PB-228 766

ASHLEY RIVER POLLUTION STUDY, CHARLESTON, SOUTH CAROLINA, JUNE - JULY, 1965. APPENDIX

Public Health Service
Athens, Georgia

1 August 1965

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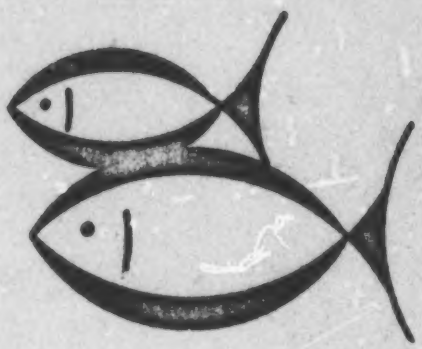
ASHLEY RIVER POLLUTION STUDY

CHARLESTON, S. C.

JUNE - JULY 1965

APPENDIX



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Public Health Service
Division of Water Supply and Pollution Control
Southeast Water Laboratory
Athens, Georgia

AUGUST 1, 1965

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The information copied below was furnished to Messrs. Fairall, Keup, and Warner on June 17, 1965 by Dr. G. Robert Lunz, Director, Bears Bluff Laboratory, Division of Commercial Fisheries, South Carolina Wildlife Resources Department.

FISH KILLS.

1961

February 23. Up Ashley River. Menhaden.

Investigated by Division of Commercial Fisheries Inspectors and specimens collected for Bears Bluff. Investigated by Water Pollution Control. "Report to be made later."

1963

June 13. Charleston Harbor, Menhaden.

Reported to Bears Bluff by radio. Not investigated by Laboratory. Said to be millions of fish floating out of Cooper River. Investigated by Health Department and one (fresh) menhaden collected off Charleston Harbor on June 15. Sent to Water Pollution Control Authority which in turn sent it to Clemson. Report no toxic material found in fish.

1964

May 12. Cooper River. Carp and Striped Bass.

Reported to Bears Bluff by Fire Department. In turn reported to State Health Department which investigated. Reported low oxygen.

1964

June 23. Ashley River. Menhaden, spot, croaker, crabs, Porpoise.

Reported to Bears Bluff by Captain Robinson of the Citadel. Investigated by Division and by Laboratory. Specimens and water samples taken. Chamberlain of College of Charleston reported disolved oxygen at 0.5 ppm. Kill apparently continued and on June 29 dead, dying and decomposing crabs taken in large numbers just outside Charleston Harbor. Local commercial Laboratory could not make analysis. Samples of crabs and fish sent to Bureau of Commercial Fisheries. They could not make analysis. Health Department sent samples to Dr. Page Nicholson of USPHS in Atlanta. No report.

On July 8 Division of Commercial Fisheries Inspector Fickling collected bottom samples in Ashley River near V-C Chemical Plant. Fish exposed to extract from mud samples, well aereated, killed mullet, spot and fundulus.

1964

Nov. 18. Ashley River. Spot, croaker, and other fish.

Water samples and fish collected by Laboratory and turned over to Water Control Authority. No report.

1965

January 26. Deformed fish found in Ashley River. Croaker and Menhaden.

Laboratory survey found croakers with tumor like growths and head bulging eyes. Menhaden with red skin irritations on "shoulders." No further investigation.

1965

May 21. Ashley River. Menhaden, spot, mullet, crabs, and 7 shrimp.

Investigated by Water Pollution Control Authority. Kill continued off and on into second week in June.

These do not include kills by unauthorized and unwise use of pesticides which were investigated by Bears Bluff Laboratories and brought to a satisfactory conclusion.

FISH KILL

A heavy kill of fiddler crabs and shrimp occurred back of the Isle of Palms, South Carolina on May 15 and for several days thereafter. As part of a mosquito abatement program a low flying plane dusted the marshes back of the Isle of Palms with BHC (Benzene hexachloride). Almost immediately fiddler crabs in the marsh began their death dance - twitching convulsively and then dying. Windrows of dead shrimp - Palaemonetes - washed up along the high water mark.

Samples of these marine specimens were sent to Dr. Philip A. Butler of the Bureau of Commercial Fisheries Laboratory in Gulf Breeze, Florida, for analysis. Dr. Butler's report showed that the shrimp and crabs contained 0.53 ppm (gammer isomer) BHC and small amounts of DDT (0.051 ppm).

Oyster samples taken back of the Isle of Palms by the South Carolina Board of Health were analyzed in Atlanta by the U. S. Public Health Service. The amount of BHC in the oysters was small (5 ppb) but shipment of seed oysters from the area was prohibited for 15 days. This resulted in a loss of revenue to the Division of Commercial Fisheries and a considerable loss to the oystermen who were shipping seed oysters from the area.

The Director of the Mosquito Abatement Project, when notified of the results of the test, agreed to stop using BHC and to change their control methods to some less toxic pesticide. Another favorable

feature arising from this kill was the suggestion from the Charleston County Council that an Advisory Board consisting of representatives from fisheries, health, and water pollution be set up to work with the Mosquito Abatement Program.

Of even greater importance in a report from a Bears Bluff Laboratories survey crew working in back of the Isle of Palms the last week in June, indicating that brown shrimp, Penaeus aztecus, appeared to be available in usual numbers and that any damage to shrimp by the spraying of BHC must have been short-lived.

The next fish kill was fantastically large. It occurred in the Ashley River and Charleston Harbor. Fish apparently began dying during the night of June 21. By early morning of June 22 that portion of the river near the Citadel (3 miles upstream from the lower tip of Charleston proper) was white with dead fish. A Bears Bluff Laboratories survey crew working in that river on a regular monthly survey, found menhaden, spot, croaker, and weakfish dead and dying. The greater number of dead and dying fish were observed between the highway bridge on State Route 7, downstream to the Citadel. By late afternnon dead and dying fish were observed on down to Fort Johnson near the entrance to the Harbor. Dr. Norman Chamberlain of the Fort Johnson Marine Laboratory took an oxygen reading in the afternoon and found only 0.5 ppm dissolved oxygen in the water.

Dead and dying fish (mostly menhaden) continued to be found in the Ashley River through June 25, and on June 29 reports began to come in on dead blue crabs being found in Charleston Harbor.

On June 30, shrimp trawlers working off the mouth of Charleston Harbor reported catching two to three bushels per drag of dead and decomposing crabs.

This Ashley River fish kill seems not to be from BHC. The mosquito abatement program is no longer using this pesticide in Charleston County. The actual cause of the kill is not being completely investigated. Bears Bluff Laboratories does not have the facilities or staff to make such investigations. Samples of the dead fish are being sent to the pesticide laboratory in Gulf Breeze, Florida.

It is difficult to understand how the fish kill in the Ashley River could have occurred naturally without some pollutant having been added to the river. If the dissolved oxygen had been reduced sufficiently to kill fish by the addition of ordinary domestic sewage, then the fish also should have died in other parts of Charleston Harbor.

Since there was a time lag between the fish kill and the beginning of the crab kill it could be hypothesized that the crabs died from scavenging fish killed by some toxic substance. This whole situation deserves complete and thorough study.

During the period of this report other fish kills were noted in South Carolina. On May 11, numerous large carp and one or two striped bass were killed in the Cooper River near the mouth of Filbin Creek. An investigation by the Water Pollution Control Authority reported low oxygen and industrial wastes as being the cause of this kill.

A few mullet were reported killed in Murrells Inlet, Georgetown County, on May 13. One fish submitted to Bears Bluff for examination was sent to Dr. Butler, who later reported that this fish contained the residue of 0.32 ppm of DDT and its metabolites.

Within a few days of this thousands of dead menhaden were reported washed up on beaches in Horry County, South Carolina. However, investigation of this "kill" showed it to be due to spillage from a torn net of a menhaden fisherman working off the South Carolina coast.

On June 20 a fish kill was reported in a small creek leading into Coosaw River in Beaufort County. Investigation by an Inspector from the Division of Commercial Fisheries, and later by the State Health Department indicated that this kill was due to a few fish being entrapped in a tidal pool where water temperatures went exceedingly high.

MISCELLANEOUS

One small fish-kill occurred in the Ashley River beginning on November 18. Fresh water catfish, stripped bass, croaker, spot and menhaden were found dead and dying. Dead fish were observed over a three day period along the river from Magnolia Gardens to the Municipal Yacht Basin. A survey crew from Bears Bluff collected water samples and dead fish on November 19. These samples were turned over to the South Carolina Water Pollution Control Authority, for determination as to the cause of the kill.

In the Ashley River on December 15 while trawling at a regular survey Station just above and across the River from the Citadel, Bears Bluff personnel collected live menahden with blood-red streaks and blotches on their bodies. Several croaker taken at the same time showed physical deformities such as tumor-like lumps on their heads and eyes which were bulbous and several times larger than normal. Presumably, these abnormalities were due to pollution.

Later on the same day more abnormal croaker were taken near the mouth of Charleston Harbor in the same location where so many dead crabs were found after the very large fish-kill of June 1964.

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DISSOLVED OXYGEN DATA

ASHLEY RIVER - CHARLESTON, S. C.

Sample date: November 18, 1964

Location	Dissolved Oxygen (mg/1.)
Buoy 13	
Surface	8.36
Bottom	8.42
Ashley River Bridge	
Surface	7.58
Bottom	7.46
First Railroad Bridge	
Surface	7.84
Bottom	7.76
Above WCSC-TV Tower	
Surface	8.94
Bottom	8.92
North Ashley Bridge	
Surface	9.10
Bottom	9.16

ANALYTICAL DATA

ASHLEY RIVER - CHARLESTON, S. C.

Sample date: May 12, 1965
Analysis: Charleston Harbor Project
Tide data: Low - 1135 EST
High - 1801 EST
Sample locations:
III Coast Guard Dock
III D ACL Bridge
III F(18) Buoy 18, at V-C Chemical Company
III F 1/5 mile above S. C. Highway 7 Bridge

Sample 1/	Time EST	Temp. °C	Total Phosphates mg/l. PO_4	Ammonia mg/l. NH_3-N	Nitrates mg/l. NO_3-N	Dissolved Oxygen mg/l.
III S	1400	25	0.19	0.3	0.1	5.0
III B	1400	25	0.44	0.7	0.2	5.4
III D S	1415	26	0.65	0.3	0.1	5.8
III D B	1415	26	0.82	0.3	0.2	5.8
III F(18) S	1510	26	1.06	0.6	0.2	5.1
III F(18) B	1510	25	1.32	0.5	0.3	5.2
III F S	1526	26	1.33	0.5	0.2	5.5
III F B	1526	26	1.33	0.5	0.2	5.5

1/
S - Designates surface sample.
B - Designates bottom sample.

CHARLESTON HARBOR STUDY
CHEMICAL & BACTERIOLOGICAL DATA - ASHLEY RIVER AT COAST GUARD STATION

DATE	TOTAL COLIFORMS per 100 ml.		FECAL COLIFORMS per 100 ml.		B.O.D. mg/l		C.O.D. mg/l	
	S	B	S	B	S	B	S	B
4-13-64	5500	5200	1050	970				
4-14-64	9100	11800	780	1000				
4-15-64	10400	2100	1280	190				
4-16-64	7100	1840	1800	180				
4-17-64	3700	960	440	>200				
4-28-64	14200	11600	3100	3200				
4-29-64	5600	2000	1960	430				
9-22-64	7600	3700	1220	340	1.4	1.4	16	97
9-23-64	6000	4600	1140	440	3.6	1.4	90	110
9-24-64	5000	3000	840	380	2.0	3.4		
9-28-64	6400	5800	720	700	1.8	1.6		
9-29-64	8400	10600	1000	960	2.6	1.1		
9-30-64	21000	12400	2100	1320	7.1	-		
10-1-64	8600	9200	1040	1480	2.4	1.4		
10-5-64	6200	5400	640	560	3.2	3.0		
10-6-64	9200	7800	1400	980	1.1	1.3	-	-
10-8-64	12400	7000	840	420	1.1	1.2	78	88
10-13-64	42000	15000	3200	1200	1.6	1.5	48	62
10-14-64	19000	22000	1700	2300	1.2	1.5	56	83
10-20-64	4000	6200	270	260	3.7	1.0		
10-21-64	7200	3600	500	200	1.1	1.2		
10-22-64	8600	15200	660	1000	1.8	2.7		
10-27-64	33000	11000	3100	980	2.6	1.3		
10-28-64	9200	9000	1800	1180	2.3	2.6		
10-29-64	21000	29000	1800	2200	1.9			
12-2-64	5000	2900	5000	150	0.9	0.2	91	107
12-3-64	1300	6600	1300	90	0.6	0.5	88	99
12-4-64	TNTC	2600	7100	108	1.5	-	92	101
12-7-64		3500	720	190	-	-	73	100
12-8-64	6000		260	125	-	-	74	93

CHARLESTON HARBOR STUDY
CHEMICAL & BACTERIOLOGICAL DATA - ASHLEY RIVER AT COAST GUARD STATION

DATE	TOTAL COLIFORMS per 100 ml.		FECAL COLIFORMS per 100 ml.		B.O.D. mg/l		C.O.D. mg/l	
	S	B	S	B	S	B	S	B
1-25-65	11000	8600	940	560	0.0	1.0	104	99
1-28-65	900	2000	50	140	1.4	1.2	22	25
2-1-65	3700	1320	260	139	1.0	1.2	20	22
2-4-65	7200	12200	550	790	1.4	1.4	20	24
2-8-65	16800	14200	1300	940	1.0	1.1	28	30
2-11-65	7400	6800	380	300	1.1	1.0	22	26
2-15-65	4000	4900	275	160	1.0	1.3	18	32
2-18-65	6000	9800	580	960	1.2	2.0	22	30
3-1-65	3900	2900	185	250	1.1	1.2	15	21
4-22-65	21200	19200	TNTC	TNTC	-	-		
4-29-65	41000	28500	3400	1350				
5-6-65	22000	TNTC	1800	1700				
5-13-65	14000	22000	2900	2800				
5-20-65	1750	7600	3000	1950				
5-27-65	5600	5000	2700	3000				
6-3-65	660	2300	LE	LE				
6-10-65	TNTC	TNTC			1.1	1.1		
6-14-65	17000	5400	2900	466	0.9	0.9		
6-15-65	19500	3800	1650	700				
7-8-65	16000	12500	3100	1500				

CHARLESTON HARBOR STUDY
CHEMICAL & BACTERIOLOGICAL DATA - ASHLEY RIVER AT COAST GUARD STATION

DATE	TEMPERATURE °C		pH		DISSOLVED OXYGEN mg/l		CHLORIDE ms/l Cl^-	
	S	B	S	B	S	B	S	B
9-22-64	24.0	24.0	7.9	7.9	6.30	6.10	10500	10800
9-23-64	24.0	24.0	7.5	7.7	6.03	6.10	9100	12100
9-24-64	24.5	25.0	7.5	7.7	5.81	5.48	8200	11700
9-28-64	25.0	25.0	8.0	7.5	5.56	5.60		
9-29-64	25.5	25.5	7.3	7.2	5.22	4.91		
9-30-64	26.0	26.0	7.5	7.5	5.40	5.39	7400	8200
10-1-64	26.0	26.0	7.5	7.4	5.15	5.70	7200	7300
10-5-64	26.0	26.0	7.8	7.9	5.50	5.10	8700	11300
10-6-64	22.0	23.5	8.1	8.1	6.40	5.63	6000	11500
10-8-64	20.5	20.5	7.6	7.8	6.88	6.70	6900	11600
10-13-64	18.5	19.0	7.3	7.6	6.92	0.00	5100	9500
10-14-64	19.0	19.0	7.7	7.7	6.94	6.82	6500	6700
10-20-64	18.5	19.0	-	-	7.02	6.83	11000	14600
10-21-64	18.0	18.0	7.6	8.0	6.86	6.84	10000	12400
10-22-64	18.0	18.0	7.7	8.0	6.90	6.76	8100	11300
10-27-64	17.5	17.5		7.4	6.94	7.02	3900	5600
10-28-64	19.0	18.0	7.5	7.5	7.04	7.36	4600	5400
10-29-64	18.0	18.0	6.5	7.4	7.04	7.14	5200	5600
12-2-64	12.0	12.5	8.1	7.9	8.22	8.16	9500	14000
12-3-64	13.6	13.6	7.8	7.7	7.90	7.90	8400	13600
12-4-64	14.5	14.6	7.3	7.5	7.84	7.90	7200	11800
12-7-64	14.8	13.8	7.5	7.4	8.34	7.74	7100	12600
12-8-64	13	13	7.3	7.3	8.44	7.80	7300	14100

CHARLESTON HARBOR STUDY
CHEMICAL & BACTERIOLOGICAL DATA - ASHLEY RIVER AT COAST GUARD STATION

DATE	TEMPERATURE °C		pH		DISSOLVED OXYGEN mg/l		CHLORIDE ms/l cl^-	
	S	B	S	B	S	B	S	B
1-25-65	10.2	10.2	7.7	7.6	9.20	9.30	7100	7400
1-28-65	10.5	10.2	7.6	7.6	9.55	8.45	8900	13000
2-1-65	9.8	8.5	7.7	7.8	9.20	8.95	8000	10400
2-4-65	9.1	9.1	8.5	8.4	9.70	9.52	5400	6700
2-8-65	10.7	10.8	7.9	8.0	9.15	9.10	7100	7200
2-11-65	12.4	11.5	7.6	7.5	9.40	8.55	8400	10300
2-15-65	11.8	11.5	7.4	7.4	8.55	8.15	10100	11000
2-18-65	10.4	10.3	7.4	7.3	7.80	8.40	3500	3700
3-1-65	9.7	9.3	7.3	7.5	9.30	9.20	7500	10700
4-22-65					6.58	6.29		
4-29-65	20	19			6.41	6.39		
5-6-65	22.0	23.0			6.26	5.92		
5-13-65	22.8	23.0			5.23	5.07		
5-20-65	25.5	24.0			5.22	5.68		
5-27-65	28.0	27.0			4.86	4.39		
6-3-65	25.8	25.8			5.04	4.70		
6-10-65	27.0	26.8			4.60	4.78		
6-14-65	25.8	26.0			4.60	4.57		
6-15-65	26.0	26.0			5.21	4.72		
7-8-65	28.4	28.8			4.20	4.18		

MEAN TOTAL PHOSPHATES
mg/l PO_4

Charleston Harbor Study

Intensive Survey A
4-Hour Cycles
Cycle 001, March 3, 1965, 8:00 AM E.S.T.
(Approx. 30 determinations available from
cycles 001 to 030 and 120 to 125)

	Station	Surface	Bottom
# 1	Entrance Harbor	.14	.18
# 2	Off Battery	.14	.31
# 3	Ashley @ CG Station	.36	.46
# 4	W. Cooper @ Degaussing Range	.16	.22
# 5	E. Cooper @ Degaussing Range	.15	.20
# 6	Cooper @ West Span Bridge	.18	.21
# 7	Cooper @ East Span Bridge	.16	.27
# 8	Entrance Cooper to Harbor	.22	.36
# 9	Entrance Wando to Harbor	.18	.28
#10	Cooper @ W. Va. Pulp & Paper	.24	.27

MEAN TOTAL PHOSPHATES
mg/l PO_4

Charleston Harbor Study - Routine Sampling

Dates	9/28/64 - 10/1/64			12/2/64 - 12/8/64			1/25/65 - 3/1/65		
Station	No. Samples	Surface	Bottom	No. Samples	Surface	Bottom	No. Samples	Surface	Bottom
1	4	0.15	.19	3	0.08	.07	8	0.08	.12
2	4	0.16	.35	4	0.06	.09	9	0.08	.23
3	4	0.45	.58	5	0.09	.11	9	0.31	.33
4	4	0.14	.18	5	0.07	.10	9	0.10	.11
5	4	0.14	.13	4	0.07	.09	9	0.11	.15
6	4	0.15	.16	5	0.07	.10	9	0.11	.15
7	4	0.14	.16	5	0.06	.11	9	0.09	.13
8	4	0.14	.14	5	0.07	.11	9	0.10	.14
9	4	0.13	.16	3	0.07	.12	7	0.10	.34
10	4	0.30	.13	5	0.09	.10	7	0.12	.12

Director, Robert A. Taft San. Engrg. Center
Cincinnati, Ohio
Attn: Mr. John M. Fairall

July 22, 1965

Regional Program Director, WS&PC
Region IV, Atlanta, Georgia

Waste Water Disposal Practices at Charleston Air Force Base

On June 24, 1965, Mr. A. B. Herndon visited Charleston AFB to survey the waste water disposal practices and determine the possibilities of this Federal Installation contributing to the recent fish kills in Ashley River. This memoranda confirms information obtained and previously given to you by telephone by Mr. Herndon.

The major portion of the industrial wastes produced at this Base comes from the aircraft wash rack. The chemicals used in this cleaning operation consist of a strong alkaline detergent, kerosene, and methylene chloride. About 55 gallons per month of methylene chloride is used, but it was reported that this material floats in the skimming tank and is removed with the oil. All of the liquid wastes from the wash rack is pumped into a 5,000 gallon skimming tank where the floating oil is removed and hauled away for burning. The ditch which receives the wastes from this tank also receives wastes from an aircraft engine wash rack and an automotive wash rack which do not have skimmers. It was reported that only a strong alkali is used at these latter two wash racks, so the only wastes going to the ditch are oils and the alkaline cleaner. An inspection of this ditch showed that it contained floating oils within the property of the Base. However, an inspection of this ditch as it leaves the Base property at Highway 642 revealed only minor indications of oil and a heavy growth of sphaerotilus.

A metal plating plant is used to provide chromium and cadmium coatings for propellers and small parts. A strip solution containing about 100 pounds of chromate acid is dumped about every six months. Prior to dumping this material it is treated to reduce the chromium to the trivalent form. About 20 gallons of chromate acid solution from the anodizing tank is treated and discharged every four to six months. The cadmium solution containing cyanide is never dumped, but the sludge is drawn off and hauled away for deep sea disposal. All of the wastes from the plating plant discharge to the sanitary sewage system where it is mixed with an average flow of 900,000 gallons per day of sewage. The sewage is treated in a primary plant with post chlorination and then discharged to the Ashley River.

Other chemicals used in the industrial operations reportedly do not reach any of the water courses. A cresylic acid compound is used as a carbon remover in small cleaning tanks, but this compound is burned when it is discarded. Methylethylketone is used in a closed spray system to remove neoprene from radomes. None of this material is discarded because the rapid evaporation makes it necessary to periodically add new material. Considering the small quantity of the methylethylketone that is used and considering its high volatility, it is doubtful that any of this material reaches the Ashley River.

In summary, it is believed that the wastes normally discharged from the Charleston AFB would not contribute to the fish kills in the Ashley River. The only time that these wastes may contribute to a fish kill would be when the chromium plating wastes are dumped. However, it was reported that none of this chromium waste had been dumped during the past several months.

Arrangements were made at the time of Mr. Herndon's visit for the personnel at the Base to provide us with any samples that may be needed of any of their wastes. If you are interested in obtaining any samples for special analysis, we can arrange for these to be picked up by the personnel at the Base.

Herbert H. Rogers

cc: Mr. John R. Thoman
Mr. Murray Stein
Mr. H. P. Stetina

SEWER OUTFALLS INTO ASHLEY RIVER
FROM SOUTH BATTERY UP TO HUNLEY PARK

The following information is from an undated report of the same title by W. B. Mustard and J. A. Woods, South Carolina Water Pollution Control Authority.

1. Church St. into Murray Blvd.
   3' square storm drain.

2. Meeting St. into Murray Blvd.
   3' square storm drain and sewage.

3. Between Meeting St. and King St. into Murray Blvd.
   10" round sewage.

4. King St. into Murray Blvd.
   2' square storm drain.

5. Limehouse St. into Murray Blvd.
   3' square storm drain and sewage.

6. Savage St. into Murray Blvd.
   2' sewage and storm drain.

7. Tradd St. into Murray Blvd.
   8" round storm drain.

8. West end of Broad St.
   3' round sewage and storm drain.

9. West end of Beaufain St.
   2-12" sewage & 1-3' storm drain.

10. West end of Calhoun St.
    3' storm drain and sewage.

11. The Inn on Lockwood Dr.
    8" round sewage.

12. West shore of Ashley R. approx. 1/4 mi. SE of Ashley River Memorial Bridge
    18" round cast iron sewage.

13. North side and adjacent to the Ashley R. Mem. Bridge on the East Shore

8" round sewage.
14" sewage and storm drain.

14. North side and adjacent to the Ashley R. Mem. Bridge on the West Shore
6" sewage pipe.

15. Chestnut St. between Allway St. and Fishburne St.
3' round storm drain and sewage.

16. Citadel
15 storm & sewer outfalls, one of which is spetic tank effluent.

17. West end of Grove St.
12" round sewage.

18. West end of Sans Souci St.
12" round sewage.

19. South side of Seaboard Airline Railroad Trestle on the West shore of the Ashley R.
18" round cast iron sewage.

20. East end of Woodward St.
12" round sewage.

21. East end of Oakdale Pl.
2-12" round sewage.

22. Millbrook Blvd. and Ashley Hall Rd. -- Sandalwood
Effluent from Big Boy Septic Tank.

23. Southeast end of Church Creek Dr.-- Springfield
Effluent from two Big Boy Septic Tanks.

24. Between Oconee St. and Hopewell St. in the Daniel Jenkins Housing Project running between two borrow pits to the Ashley R.
12" round sewage.

25. Wando Creek
Storm drainage for Union Hgts.

26. South side of New Ashley River Bridge on the East shore
12" round sewage.

27. Southwest end of Bonds Ave. running under the Jenkins Orphanage & connecting with the Ashley Shores Townhouse Subdivision
18" round sewage.

28. West end of Paramount St. in Wando Woods
6" round sewage.

29. West end of Paramount St. in Wando Woods
4' drainage ditch.

30. Northwest end of Apple St. in Wando Woods
12" round sewage.

31. Air Force Base and Hunley Park
24" round cast iron sewage -- treated.

SEWAGE LIFT STATION INVESTIGATIONS

Introduction

Sampling of domestic waste loads in connection with the Charleston Harbor Project was initiated on March 17, 1964. This report is concerned with the sampling, and the qualitative results obtained. Quantitative results in the form of discharge measurements are not discussed in this report.

Description of Sewer System

The disposal of waste water from the sewer system for the City of Charleston at the present time is accomplished by thirteen lift stations. Untreated wastes are discharged through pressure mains from all of these stations with the exception of two which are chlorinated. Discharge of the wastes is directly into the Charleston Harbor.

Control of lift station pumps is automatic. The level of waste water in the station wet well serves to switch on the pumps through a system of solenoid switches. This is a standard switching control device used in installations of this type.

The City of Charleston originally had a separate sewer system in service. At this time, however, cross connections of sanitary lines to storm drainage lines are believed to exist. The number of cross connections and the volume contributed by these connections was not investigated in this survey. Future plans call for studies to collect detailed information on the cross connections and waste loads contributed by the connections.

Sampling

The sampling program discussed in this report covered ten of the thirteen lift stations serving Charleston, S. C. Initial sampling began on March 17, 1964 and continued through April 10, 1964. All of the samples taken were grab samples, obtained by means of a sewer sampling device. One liter polyethylene bottles were used as sample containers. Approximately one hour was required to sample all ten of the stations and 35 to 40 minutes for the sampling of the five stations during the 24-hour run. The samples were returned to the laboratory in ice chests.

7-23-65

NOTE: Stations 1-5 discharge to the Ashley River. Data for these stations only is included.

On April 8th, an intensive sampling program was begun which involved sampling the stations once every two hours for a 24-hour period. The stations were divided into two groups of five each with samples being taken over one 24-hour period from each group. During the sampling period prior to the 24-hour studies, one group including all of the ten stations had been sampled twice per day. In the latter studies, morning and afternoon variations of waste strength were studied while hourly variations were determined from the 24-hour studies.

Weather conditions during the study varied from fair and warm to mild with periods of heavy rainfall. The periods of heavy rainfall would be of great interest because of infiltration that would be present in an older sewer system such as the one in use in Charleston.

Tests

The primary parameter used in evaluating qualitatively the sanitary sewer system was the Biochemical Oxygen Demand. This demand was determined at all stations throughout the entire survey. During the 24-hour studies, total coliform and Fecal streptococcus determinations were made in addition to the BOD determinations. Samples for bacteriological analysis were collected every four hours.

With the exception of the 24-hour studies, analyses were made in the temporary laboratory facility. BOD and bacteriological determinations during the 24-hour studies were made by the staff of the mobile laboratory from the Sanitary Engineering Center.

Discussion

Because of widely varying results of the various lift stations, the discussion section will be of each station.

Station No. 1 is located in a residential section of the Northwestern Sector of Charleston. Service connections for this station are domestic with no large industries discharging into the lines. Average values of BOD obtained for morning and afternoon samples were 147 mg/l and 123 mg/l respectively. In the 24-hour study, the daily cyclic variation was quite evident. Peak concentrations occurred at 6:00 pm (April 8, 1964), 8:00 am (April 9, 1964), and at 4:00 pm (April 9, 1964). Peak concentrations for total coliform counts and Streptococcus fecalis counts occurred at corresponding times with the peak concentrations of BOD. Variation of the bacterial concentrations with the BOD concentration is illustrated in Figure 2.

The area served by Lift Station No. 2 lies in the Western section of Charleston. Service in this area includes domestic, service station, laundromat, grocery store, and other small business connections. One service, a dairy products processing plant, will require individual study so that its operating schedule and waste load may be determined. Discharges from the dairy would be a possible explanation for higher values of BODs obtained at various sampling times during the survey.

Morning and afternoon average BOD values were 161 mg/l and 153 mg/l, respectively. A peak value of 336 mg/l was observed during the 24-hour study. Figure 4 shows BOD values increasing by 50% while the numbers of organisms decreased by approximately 50%. Peak concentrations of indicator organisms occurred from two hours to four hours in advance of highest concentrations of BOD.

Service area of Lift Station No. 3 extends from the center of Charleston's business district westward and southwestward to the Ashley River. Included in the area are numerous business establishments, residences, and service stations. A total of seven hospitals located in this area are connected to the City sewer system. Length of travel time is very long for some of the connections served by this Station due to the distance covered.

Average values for the BOD obtained from the daily variation studies are 151 mg/l for the morning and 223 mg/l for the afternoon. Hourly variations in BOD values are shown by a well-defined curve in Figure 5. The maximum concentration of 284 mg/l was recorded at 8:00 pm on April 9. Peak concentrations for the microbiological organisms occurred at the same time. With the exception of the 8:00 pm to 12:00 m period, increases of BOD concentrations were accompained by increases in concentrations of total coliform and fecal streptococcus organisms. Concentrations of the total coliform organisms ranged approximately 10 times greater than the concentrations of the fecal strepococcus organisms.

Lift Station No. 4 serves an area in the southwest sector of Charleston. Service connections range from residential to office and small businesses with the majority of the connections being residential.

Identical results were obtained for the morning and afternoon average BODs. The value was 154 mg/l. Hourly variations for the 24-hour study showed peak concentrations of 133 mg/l and 263 mg/l for BOD determinations. Maximum values of microrganism concentrations preceded maximum values of BOD by approximately two hours.

A small residential area is served by Lift Station 5. The area lies on the southwest tip of the penisula on which Charleston is situated.

Results of the daily variation studies show an average morning BOD value of 119 mg/l and an average afternoon BOD value of 163 mg/l. The 24-hour study gave maximum BOD values of 120 mg/l and 208 mg/l. Total coliform concentrations did not range greater twice the fecal streptococcus concentrations at any time during the 24-hour study.

Lift Station No. 6 serves the samllest area of the Charleston sewer system. The location of the area is the southeastern tip of the city. Discharge for this station is into a storm drain located on the East Battery along the Cooper River.

Average values of morning and afternoon BODs were 119 mg/l and 168 mg/l respectively. Figure 11 shows the hourly variations of the 24-hour study. Figure 12 shows a departure from the direct variation of indicator organisms; the deviation may be seen in the last four hours of the 24-hour sampling study.

The business section located east of King St. and south of George St. is the area served by Lift Station No. 7. Discharge from this station is in the Cooper River in the main waterfront section.

Average values of daily BOD concentration showed little variation. The average BOD for the morning samples was 147 mg/l, and the average BOD for the afternoon samples was 144 mg/l. Peak concentrations of indicator organisms preceded maximum BOD concentrations by approximately two hours. Concentrations of total coliform organisms ranged from 4 to 6 times greater than the concentrations of fecal streptococcus organisms.

Service for the business district east of King St., north of Laurens St., and south of Chapel St. is by Lift Station No. 8. Connections of all types are located in this area, with businesses comprising the greatest majority of the connections. Discharge of this station is into the Cooper River near the Charleston Drydock and Shipbuilding Company.

Average values for morning and afternoon BOD samples were 128/mg/l and 131 mg/l, respectively. Results obtained in the 24-hour study were erratic. Peak evening concentrations of BOD and indicator organisms preceded maximum BOD concentrations by two hours during the morning hours. Samples taken during the morning hours showed total coliform concentrations 9 times those of fecal streptococcus concentrations. Afternoon samples had total coliform concentrations five times the fecal streptococcus concentrations.

The area served by Lift Station No. 9 is a very densely populated residential section. There are some business establishments located in this area, but crowded apartment dwellings occupy the largest percentage of the area.

Average values of morning and afternoon BOD samples were the highest of all the stations. The morning value was 199 mg/1 whicle the afternoon BOD was 161 mg/1. In the 24-hour study, a maximum BOD value of 521 mg/1 was recorded for the morning peak. Concentrations of indicator organisms ranged higher than at the other lift stations. Figure 18 shows that a wide variation of fecal streptococcus and total coliform concentrations existed during the survey The wide variation of fecal streptococcus concentrations with respect to total coliform concentrations may be seen also in Figure 17.

Lift Station No. 10 serves an area in the northeastern section of Charleston. The area is primarily residential with two family dwellings comprising the largest percentage of residences. The majority of the small businesses located in this area lie in the western section along main thoroughfares. Discharge from this station is into Vardell Creek, above the entrance of the creek into the Cooper River.

Average BOD for the morning samples was 173 mg/1 while the average afternoon BOD was 140 mg/1. A value greater than 453 mg/1 was recorded as the maximum BOD during the 24-hour study. Variation of the indicator organisms concentration with respect to the BOD concentration was erratic. Figures 19 and 20 illustrate hourly variation and the foregoing statement.

Station	Date	Time	BOD mg/l	Total Coli: organisms/ 100 ml	S. fecalis organisms/ 100 ml
1	3/17/64	2:25 pm	149		
	3/18/64	9:10 am	199		
		2:10 pm	177		
	3/25/64	3:55 pm	150		
	3/26/64	10:10 am	59		
	3/27/64	9:50 am	87		
	3/30/64	9:15 am	164		
		3:00 pm	87		
	3/31/64	12:10 pm	152		
		3:25 pm	170		
	4/1/64	9:20 am	190		
		3:00 pm	77		
	4/2/64	10:00 am	140		
		3:15 pm	117		
	4/3/64	10:36 am	43		
		2:48 pm	60		
	4/8/64	6:30 pm	221		
		8:30 pm	139	13,100,000	1,700,000
		10:25 pm	101		
	4/9/64	12:30 am	81.3	6,000,000	500,000
		2:20 am	42.0		
		4:25 am	10.4	1,050,000	105,000
		6:30 am	31.0		
		8:25 am	175	24,000,000	4,700,000
		10:25 am	154		
		12:30 pm	169	8,600,000	2,900,000
		2:20 pm	192		
		4:30 pm	220	9,300,000	1,600,000

Station	Date	Time	BOD mg/l	Tot. Coli. organisms/ 100 ml	S. fecalis organisms/ 100 ml
2	3/19/64	8:10 am	207		
		3:35 pm	165		
	3/20/64	10:15 am	158		
		3:00 pm	197		
	3/26/64	10:20 am	152		
	3/27/64	------	---		
	3/30/64	9:25 am			
		3:09 pm	149		
	3/31/64	12:20 pm	242		
		3:35 pm	230		
	4/1/64	9:25 am	160		
		3:05 pm	107		
	4/2/64	10:05 am	47		
		3:23 pm	83		
	4/9/64	6:25 pm	86.5		
		3:30 pm	165	50,000,000	5,100,000
		10:30 pm	193		
	4/10/64	12:30 am	244	25,000,000	1,700,000
		2:30 am	75.0		
		4:40 am	18.0	7,400,000	310,000
		6:35 am	26.0		
		8:45 am	146	45,000,000	7,300,000
		10:30 am	336		
		12:30 pm	172	80,000,000	6,800,000
		2:30 pm	215		
		4:32 pm	80.7	4,400,000	800,000

Station	Date	Time	BOD mg/l	Tot. Coli. organisms/ 100 ml	S. fecalis organisms/ 100 ml
3	3/19/64	8:25 am	176		
		3:40 pm	182		
	3/20/64	10:20 am	215		
		3:15 pm			
	3/26/64	10:25 am	69		
	3/27/64	10:10 am	185		
	3/30/64	9:30 am	259		
		3:15 am	247		
	3/31/64	12:25 pm	247		
		3:39 pm	270		
	4/1/64	9:30 am	230		
		3:10 pm	247		
	4/2/64	10:10 am	133		
		3:30 pm	223		
	4/3/64	10:45 am	163		
		2:55 pm	127		
	4/8/64	6:00 pm	116		
		8:45 pm	102	40,000,000	3,400,000
		10:40 pm	177		
	4/9/64	12:40 am	117	36,000,000	4,100,000
		2:35 am	91.7		
		4:40 am	57.8	20,000,000	1,600,000
		6:45 am	44.0		
		8:45 am	284	74,000,000	7,700,000
		10:40 am	219		
		12:45 pm	237	38,000,000	5,000,000
		2:45 pm	243		
		4:40 pm	120	20,000,000	1,900,000

Station	Date	Time	BOD mg/l	Tot. Coli. organisms/ 100 ml	S. fecalis organisms/ 100 ml
4	3/23/64	9:20 am	215		
		2:50 pm	132		
	3/24/64	9:00 am	266		
		2:00 pm	108		
	3/26/64	10:35 am	52		
	3/27/64	8:53 am	43		
	3/30/64	8:40 am	137		
		1:42 pm	220		
	3/31/64	11:20 am	192		
		2:44 pm	195		
	4/1/64	8:45 am	140		
		2:15 pm	173		
	4/2/64	9:07 am	210		
		2:35 pm	153		
	4/3/64	9:50 am	127		
		2:14 pm	97		
	[illegible]/9/64	6:00 pm	108		
		8:00 pm	121	32,000,000	3,100,000
		10:05 pm	133		
		12:05 am	99.5	14,000,000	2,300,000
		2:00 am	45.2		
		4:10 am	28.7	9,600,000	510,000
		6:00 am	16.8		
		8:05 am	134	[illegible],000,000	9,100,000
		10:00 am	261		
		12:00 pm	151	18,000,000	2,600,000
		2:00 pm	152		
		4:02 pm	212	39,000,000	4,700,000

Station	Date	Time	BOD mg/l	Tot. Coli. organisms/ 100 ml	S. fecalis organisms/ 100 ml
5	3/17/64	1:45 pm	160		
	3/18/64	8:35 am	142		
		1:35 pm	152		
	3/25/64	3:10 pm	103		
	3/26/64	8:55 am	16		
	3/27/64	9:04 am	50		
	3/30/64	8:45 am	139		
		2:25 pm	152		
	3/31/64	11:25 am	159		
		2:48 pm	174		
	4/1/64	8:50 am	163		
		2:24 pm	180		
	4/2/64	9:15 am	103		
		2:40 pm	243		
	4/3/64	9:58 am	183		
		2:19 pm	143		
	4/9/64	6:10 pm	38.3		
		8:15 pm	65.5	14,800,000	1,540,000
		10:10 pm	120		
		12:15 am	71.2	15,200,000	3,000,000
		2:15 am	43.1		
		4:20 am	28.7	4,000,000	230,000
		6:15 am	17.1		
		8:20 am	96.0	20,000,000	4,900,000
		10:20 am	208		
		12:05 pm	161	5,000,000	2,500,000
		2:15 pm	181		
		4:08 pm	153	6,600,000	1,120,000

TO : Records

DATE: June 18, 1965

FROM : John M. Fairall, Chemical Engineer Consultant
T. A. & I. Section, Robt. A. Taft Sanitary Engineering Center
Cincinnati, Ohio

SUBJECT:

V-C Chemical Company, Chemicals Division
Organic & Inorganic Chemicals
Charleston, South Carolina
Ashley River, Charleston Harbor

1. Date of Meeting--June 16, 1965

2. Personnel Participating

W. K. Enos, General Superintendent, V-C Chemical Company
Charleston, S. C.

G. A. Rhame, Assistant Director, S. W. Water Pollution Control
Authority, Columbia, S. C.

John M. Fairall, Chemical Engineering Consultant, Robert A.
Taft Sanitary Engineering Center, Cincinnati, Ohio

3. Purpose

The purpose of this meeting was to determine the nature of the water-borne discharges from this facility as they might relate to the reported death of fish in the Ashley River.

GENERAL INFORMATION

4. Organization

The V-C Chemical Company is a Division of Socony Mobil Oil Company, Inc. with the main office in Richmond, Virginia. Other chemical plants are located at Fernald, Ohio; Mt. Pleasant, Tenn; and Hammond, Indiana. A super phosphate fertilizer plant of the Agricultural Minerals Div. of the V-C Chemical Company is located on adjacent property at Charleston.

5. Raw Materials

Phosphate Rock
Coke
Gravel
Soda Ash
Caustic Soda
Chlorine
Alcohols
Hexane
Pentane
Butylmercaptan

6. Products

Inorganic Chemicals
- Elemental Phosphorous
- Phosphoric Acid
- Phosphoric Anhydride
- Phosphorous Trichloride
- Disodiam Phosphate
- Trisodium Phosphate

Organic Chemicals
- Dialkyl Phosphites $(RO)_2$, P (O)H
  - Dimethyl, diethyl, dibutyl, bis (2-ethylhexyl)
- Dialkyl Alkylphosphonates R-P (O) $(OR)_2$
  - Diethyl ethyl, dibutyl butyl, bis(2-ethyhexyl) 2-ethyhexyl
- Trialkyl and Alkyl Aryl Phosphites $(RO)_2P$
  - Trimethyl, triethyl, tris(2-chloroethyl), triisopropyl, tributyl, tris(2-ethylhexyl), triisooctyl, 2-Ethylhexyl oxtylphenyl
- O,O,O-Trialkyl Phosphorothioates $(RO)_3PS$
  - Triethyl, tributyl, triisooctyl
- Organic Acid Phosphates
  - Methyl, ethyl, isooctyl, stearyl, phenyl, octylphenyl, PA-75
- Vicro-Pet 20
- Vicro-Pet 30
- Vircol 82 (urethane flame retardant)
- Vircol 189 (polyvinyl alcohol plasticizer)
- Tributyl Phosphate
- Folex (6 pounds Merphos (95% min. tributyl phosphorotrithioite) per gallon) (Defoilant)
- V-C 13 (Nematocide) (O,O-diethyl, O-(2,4-dichlorophenyl) phosphorothioate)

7. Operations

The production of all inorganic phosphates and merphos is continuous. The other chemicals (organic phosphates) are made in batches. The plant production capacity is confidential.

8. Water Supply

The cooling water for the phosphoric acid plant is river water pumped at the rate of 600 gpm. A similar amount of river water is pumped for cooling the carbon block reactor of the electric furnace. All other water is purchased from public supplies.

9. Points of Discharge

There are three separate discharges from the property:

(a) The drain from the phosphorous settling ponds, 50 gpm

(b) The returned cooling water, 1200 gpm

(c) The "River Ditch" which receives the flow from the "Organic Drain" (bearing about 30 gpm of cooling water from the production of the organic compounds), the hot well for the merphos unit, the "Upper Ditch," and the "Limestone Ditch" (bearing waste acid from merphos unit). The total flow is about 60 gpm.

10. Outline of Process

Elemental phosphorous is produced from phosphate rock in the electric furnace. Phosphoric acid is produced by the combustion of phosphorous. The inorganic phosphates are produced from the acid. The organic acids are produced from the combining of the required alcohols and the acid.

WASTE SOURCES

11. Cleaning

The organic phosphates are produced in runs of 10 to 15 batches of the same product and then the reactor is cleaned with approximately 10 gallons of hexane. Approximately one gallon of product is washed from the interior of the reactor. This solution is discharged to the "Organic Drain."

12. Vacuum Jets

The merphos unit is operated under vacuum. This vacuum is maintained by an ejector and barometric condenser. The waste condenser water is monitored in the "Hot Well". There are also hot wells in the organic plant.

WASTE CONTROL

13. Distillation

There are not any still heels in this operation. The pentane or hexane goes over the top of the still for reuse and the product organic phosphate remains.

14. Line Stoppage

In case process lines are plugged, they are cleaned with hexane and all waste material is disposed of by incineration.

15. Phosphorous Condenser

The phosphorous vapors (including carbon monoxide and dust) from the electric furnace are passed through a Cottrell precipitator for dust recovery. The dust free vapors and gases are then passed through the phosphorous condenser where they are sprayed with recirculating (phossy) water. The phossy water passes through settling tanks for recovery of phosphosur and the phossy water is recirculated to the condenser.

About 50 gpm of this recirculating water is bled off and replaced with fresh water. The bleed flow discharges to a settling tank for phosphorus recovery and then discharges to one of two parallel phosphorous settling ponds.

WASTE TREATMENT

16. Phosphorous Settling Ponds

These ponds have a nominal holding time of 24 hours. About once a year they are cleaned by decanting and removing the sludge (under water) by hand. The sludge is returned to the electric furnace. The pond overflow is about 50 gpm at 10 ppm P_4. P_4

17. Limestone Ditch

In the production of merphos, hydrochloric acid is a waste product. This waste water is discharged to the "Limestone Ditch" where it is neutralized to about 6 to 6.5 pH, before being discharged to the "River Ditch." Limestone is added to this ditch periodically.

SURVEY DATA

18. December 1964 Samples

The S. C. Water Pollution Authority picked up waste water samples about December 12, 1964. The sample from the southern-most outfall (River Ditch) showed 0.5 ppm tributyl phosphorotrithioite (merphos) when analyzed by the S. C. Department of Agriculture, even though the merphos unit had been out of production for several weeks. A river sample, collected the same date, did not show any merphos.

19. May 1965 Production

Production	Organic Chemicals Produced
5/13	merphos, triethylphosphite
5/14	merphos, trimethyl phosphite, triethyl phosphite
5/15	merphos, trimethyl phosphite, triethyl phosphite, Vercol 82 (started and continued through the month)

The phosphorous settling ponds were not cleaned during this period.

20. Waste Flow Sampling

V-C collects daily grab samples from the following locations, composites the grabs for one week and analyzes them. The results are reported as follows for merphos and merphos oxide.

Location	Week of 5/10/65	5/17/65	5/18/65	5/24/65
Organic Drain	2.60 ppm	5.80 ppm	0	0
Hot Well	0	0	0	0
Upper Ditch	0	0	0	8.20 ppm
Limestone Ditch	0	0	0	0
River Ditch	0	0.60 ppm	0	0

SUPPLEMENTARY INFORMATION

21. Bioassays

V-C Chemical Company reports that they have tried to run bioassays but have experienced difficulty in maintaining a stock of fish.

22. Merphos Sample

V-C Chemical Company furnished a 4 oz. sample of 95% merphos for our use in standardizing analyses.

TO : Record

DATE: June 18, 1965

FROM : John M. Fairall, Chemical Engineer Consultant
T. A. & I. Section, Robt. A. Taft Sanitary Engineering Center
Cincinnati, Ohio

SUBJECT:
Koppers Company, Inc.
Forrest Products Division
Charleston Heights, S. C.
Ashley River-Charleston Harbor

1. Date of Meeting--June 16, 1965

2. Personnel Participating

D. E. Curtice, Plant Manager, Koppers Company, Inc. Charleston, S. C.
G. A. Rhame, Asst. Dir. S. C. Water Pollution Control Authority
John M. Fiarall, Chem. Engr. Consultant, RATSEC, Cincinnati, Ohio

3. Purpose

The prupose of this meeting was to determine the nature of the water-borne discharges from this facility as they might relate to the reported fish kill in the Ashley River.

GENERAL INFORMATION

4. Organization

This plant of the Forest Products Division of the Koppers Company, Inc. was constructed about 1930 and has remained substantially the same since then.

5. Raw Materials

Poles, timbers, lumber
Pentachlorophenol
Creosote
Wohlman Salts

6. Products

Treated Wood Products

7. Operations

The treating operations run 24 hours per day about six days per week.

8. Employees

Approximately 125 people are employed at this plant.

9. Water Supply

All water is purchased from the City of Charleston. Last year, 21 million gallons were purchased.

10. Points of Discharge

All sanitary wastes are treated in septic tanks and tile fields.

There are two surface water discharges to the Ashley River. The northern one consists of yard drainage and some discharges from Planters Fertilizer. The principal discharge ditch reaches the River in the vicinity of the dock.

11. Outline of Process

Material to be treated is charged into the cylinders and usually steam conditioned with live steam at 245° F. The water is drained to the ditches and a vacuum is pulled on the cylinder. Next the cylinder is filled with one of the preservatives and pressure treatment takes place at 200 psi. The preservative is returned to the working tank and a vacuum is pulled on the cylinder. Preservative is reclaimed from the water drained from the cylinder.

Wohlman salts are used about once a month. About four times as much timber is treated with creosote as with pentachlorophenol.

About half of the condensate is returned to the boilerhouse. The balance is discharged to the Sump Tank.

Creosote is received by barge two or three times per year. During the week of June 7, 1965, a barge was unloaded.

WASTE CONTROL

12. Blow Tank

The waste water containing pentachlorphenol from the cylinders is discharged to the blow tank where the preservative floats and is transferred to the working tank for reuse. The remaining waste water is discharged to the yard ditch. The blow tank is to be replaced.

13. Sump Tank & Decanters

The waste water containing creosote from the cylinders is discharged to the Sump Tank. The creosote settles to the bottom and is transferred to the dehydrator. The water is pumped to four decanters in series where the water is removed by skimmers and discharged to the yard ditch. The creosote is pumped from the bottom of the decanters to the dehydrator. Water is vaporized in the dehydrator and the creosote is returned to the working tank for reuse.

SOURCES OF WASTES

14. Yard Ditches

The waste water from the Blow Tank and the Decanters along with the yard drainage are the principal sources of pollutional material. The bottom of these ditches are deposited creosote. In dry weather the flow is about 10 to 15 gpm.

NOT BOARDED

F. E. DeMartini, Chief
Tech. Adv. & Inv. Sec.
Tech. Servs. Br., WSPC
Richard Warner, John Fairall, & Lowell Keup
Tech. Adv. & Inv. Sec.
Tech. Servs. Br., WSPC

June 24, 1965

Summary of individual discussions concerning fish-kill investigations, Ashley River, Charleston, S. C., June 14-18, 1965.

Dr. C. Robert Lunz, Director
Division of Commercial Fisheries and Bears Bluff Laboratories
South Carolina Wildlife Resources Department

Dr. Lunz feels that there were at least two different causes of fish deaths. A fish-kill of a year ago (Circa June 1964) he attributes to defolients. This was apparently a large kill that covered a wide area. Large numbers of dead crabs were reported taken by trawlers in the outer harbor, downstream from the junction of the Ashley and Cooper Rivers. All of the dead and decomposing crabs were reported to have a "distinctive" odor of defolient.

The large fish-kill of May 1965 was believed to have been caused by a different agent. The reason that Dr. Lunz suspected a different agent was a difference in the "pattern" or "nature" of the kill and a lack of defolient-type odors.

Fish specimens from the large 1964 kill were sent to the Athens Pesticide Laboratory (Nicholson) for analysis. No results have been reported. Some of these fish were also sent to Dr. Butler, Fish and Wildlife Service, Pensacola, Florida, for analysis. No results have been reported from Pensacola.

Dr. Lunz mentioned several sources of pollutants that could have caused the fish-kills: (1) effluents from J. M. Moore Company, which steams out used drums for re-use; (2) unknown pollutants in Brickyard Creek, which produced a "burned" appearance on some vegetation in and about the creek; (3) solvents used at Charleston Air Force Base for aircraft cleaning; (4) effluents from Virginia-Carolina Chemical Company, which produces a defolient (Morphos) and which was "very active" at the time of the May, 1965 fish-kill; (5) spraying of marshes by the Charleston County mosquito abatement program with Ortho DiBrom-14 (this chemical was found by Lunz to be lethal to post-larval shrimp at 2.5 ppb).

Dr. Lunz stated that, although there was an extensive fish-kill in June of 1964 and one starting about May 13, 1965, fish are dying in notable quantities throughout the year. Dr. Lunz felt that the major

kill of 1964 was caused by the defolient produced at V-C Chemical Company and that that of 1965 was not, since fish killed in 1965 did not produce the "characteristic" defolient odor.

During a telephone conversation with Mr. Koup, Dr. Lunz said that seagulls on the Ashley River would not eat fish from the fish-kill of 1964.

NOTE: Attached are copies of:

(1) Summary of fish-kill history in Ashley River, compiled by G. R. Lunz;

(2) portions of Bears Bluff Laboratories Progress Reports No. 60 (April thru June 1964) and No. 62 (October thru December 1964) that deal with fish-kills.

Dr. E. Milby Burton
Director, Charleston Museum

Dr. Burton stated that seagulls would not eat fish which died in the fish-kill of 1964, in which the "defolient" odor was produced by the fish, and that many seagulls left the area. Of 1,000 young Brown Pelicans banded by T. A. Beckett, III, 125 died. This was an unusually high mortality. Some of these birds were paralytic. Last year, unusually high numbers of Brown Pelican eggs were infertile. Dr. Burton said that, last year, Red Breasted Merganzers were observed dying of convulsions, and that these birds had been eating shrimp. Dr. Burton also said that, last year on Drum Island, White Ibis and young Cattle Egret were observed dead or dying in and about stagnant pools. Many fiddler crabs were also killed.

Dr. Burton noted dead and dying menhaden last year on the Ashley River upstream at the Charleston County line. This is saline water at times.

Note: The massive kill of birds and crabs on Drum Island last year occurred shortly after the local Mosquito Abatement Program sprayed the area with BHC (benzene hexachloride).

Mr. George A. Rhame
Asst. Director, S. C. Water Pollution Authority

Mr. Rhame stated that he had never been "in on" any of the kills. He stated that dead fish were observed in the estuary at various times during the year, and suggested that some of these may have died during the large fish-kills and at a later time floated out of backwater areas giving a false impression of a protracted period of time for each fish-kill.

Mr. Rhame provided a file containing information on past fish-kills in the Ashley River and correspondence concerning these kills. That information which is pertinent has been copied and is in our possession.

Mr. Rhame expressed concern about cleaning agents used at the Charleston Air Force Base, and about "burned" rushes and other plants in Brickyard Creek, downstream from the Burrus Chemical Company and the Moore Barrel Company. He stated that strong "defolient" odors had been noted on the river, apparently originating at the V-C Chemical Company.

Mr. Max Hoskey, Jr.
Mosquito Abatement Program, Charleston County

Use of BHC (benzene hexachloride) was discontinued in August 1964. Since that time, Malathion has been the primary organic insecticide used. Airplane spraying was restricted to inaccessible off-shore islands. Other applications are done by fogging from ground machinery. Paris-green pellets are used as a larvicide in the hydraulic spoil banks along the Cooper River.

No insecticides have been used on the Ashley River since the Abatement District was established (3 years ago). No mosquito controls have been effected yet this year because of abnormally low mosquito populations.

KWarner:jw

NOT BOARDED

F. E. DeMartini, Chief
Tech. Adv. & Inv. Sec.
Tech. Servs. Br., WSPC
L. Koup, Richard Warner, and J. Fairall
Tech. Adv. & Inv. Sec.
Tech. Servs. Br., WSPC

June 24, 1965

Fish-Kill investigation Ashley River, Charleston, S. C.: Biological Field Observations, June 15-18.

1. Extent of Fish Deaths - During the field study period fish-deaths were not extensive nor were they occurring in large numbers. Fish deaths were confined to a two-mile reach of estuary extending upstream from the Seaboard Railroad Bridge. Precise estimates of the numbers of dying fish are not possible. The largest concentration (not over 5,000) of fresh-carcasses were found on June 15. On subsequent days fresh-carcasses were less evident (not over 1,000). On June 16, 17, & 18 the area in which fish were in distress was localized near the North Ashley (Highway 7) bridge. Dying fish were observed in this area regardless of tidal conditions.

2. Dead and Dying Fish - Menhaden were the only observed species that were affected. The specimens had an abnormally high number of parasites. Approximately ten percent of the carcasses and dying fish exhibited abnormal coloration around the eyes. Vivid red colored areas extended as a band from behind the eyes forward across the frontal area of the head.

3. Oysters - Intertidal oysters were observed growing on the tidal flats and upon pilings throughout the area investigated. Numbers of oysters appeared to be less in the reach of water near V-C (Virginia-Carolina) Chemical Company and the Koppers Co. wood plant. Shells were less evident and many of them did not contain animals.

4. Observations were also made on two tributaries of the Ashley River.

   A. Brickyard Creek was viewed. Local people were concerned with the "burned" appearance of vegetation at a point near the county highway department and mosquito abatement headquarters. Sedges in the marsh were discolored. Without intensive study, it appears that large quantities of heavy weight oil could have been the cause. Older growths of the sedges appeared to be darkened by some coating agent. Recent growths (including the base of the darkened stems) appeared to be normal colored. In general this tidal stream appears to be receiving large quantities of pollutants.

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D. The small stream leaving the Charleston Air Force Base was examined. Large quantities of oil were present in the bottom soils. Biota was predominantly light slime growths covering the rocks. Macro-bottom animals were not observed. The stream was atypically high because of recent rainfall.

5. Samples Collected

A. Three lots of dying menhaden were collected. Blood specimens were taken from these. Preservation of samples (fish and blood) was by freezing.

B. One lot of fish was frozen without blood samples being collected.

C. Four pint bottles of water were collected in the area where most fish were observed in distress (North Ashley, or Highway 7 bridge).

D. Oyster samples were collected from Prison Farm dock or waste outfall (point most upstream), dock pilings near V-C Chemical Co. and Koppers Co., Seaboard Railroad Bridge, and Charleston Yacht Club. Dr. Robert Lunz secured "control" oyster specimens from an "open" or unpolluted shellfishing area.

E. Bottom mud samples were collected near:

(1) Koppers Co. outfall.

(2) V-C Chemical outfall from Morphos plant.

(3) V-C Chemical Co. outfall from elementary phosphorus plant.

(4) North Ashley (Highway 7) bridge.

LMcup:jw

OPTIONAL FO. 4 (10)
MAY 1962 EDITION
GSA GEN. REG. NO. 27

UNITED STATES GOVERNMENT

Memorandum

TO : John R. Thoman
Director, Southeast Water Laboratory

DATE: July 13, 1965

FROM : Principal Biologist, Land Drainage Studies
Southeast Water Laboratory

SUBJECT: Investigation of Fish Kills in Charleston Harbor

A Survey of Industries and Their Wastes in the Ashley River Portion of Charleston Harbor

Mr. Charles Beall of the South Carolina Water Pollution Control Authority and myself visited the following plants on June 22 through June 26:

A. V. C. Chemical Company, where we talked with Mr. Enos, plant manager, requesting that we be allowed to obtain samples from the various effluents at the V. C. Plant. Samples designated (CSC-#) were obtained from the following outfalls:

(CSC-1) from the Merphos Plant effluent, normal rate of flow approximately 500 gallons per minute; (CSC-5) from a pipe discharging effluent from the phosphoric acid plant at the rate of about 20 gallons per minute; (CSC-4) from a common ditch accepting wastes from both the Merphos Plant and the effluent from the phosphoric acid plant, total flow about 520 gallons per minute; (CSC-2) from the phosphorus furnaces which included a mixture of cooling and process water, flow approximately 50 gallons per minute which contained quite a heavy load of what appeared to be colloidal or suspended phosphorus; (CSC-3) from the cooling water effluent obtained from wells, flow rate approximately 60 gallons per minute, which during sampling left an oily film on both the can and the sampler's hands; (CSC-6) from a cooling water effluent obtained from salt water, flow approximately 600 gallons per minute.

B. Two fertilizer plants operated by V. C. Company Fertilizer Division. The first of these plants visited, located on the north side of V. C. Chemical Company Plant, makes both fertilizers and sulfuric acid. A sample (CSC-8) of the waste effluent, which is passed through a settling tank, was obtained from this plant. It might be expected to contain fluoride in combination with silicate along with some hydrogen sulfide produced in their fertilizer manufacturing processes and metals from their boilers and condensing coils. The second plant, located south of the V. C. Chemical Company Plant, produces only sulfuric acid. Its wastes consist entirely of cooling water except on those rare occasions when they might have an accidental leak of sulfuric acid. A sample of (CSC-7) of this effluent was obtained to check for presence of metals coming from their boilers and cooling condensers. The flow rate from the effluents of each of the above plants was approximately 50 gallons per minute.

C. The Planter Fertilizer Plant (Mr. A. C. Palmer, plant manager) also produces sulfuric acid and fertilizer. A sample (CSC-9) of its effluent, which does not pass through a settling tank was obtained. Discharge from

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this plant was approximately 50 gallons per minute.

D. The Agrico Fertilizer Plant (Mr. G. E. Richardson, plant manager) produces both sulfuric acid and fertilizers. However, this plant has a reclaiming process for removing the fluorides and sulfides from their waste. Cooling water from the sulfuric acid plant could contain metals. No sample of this was obtained.

E. Next, we visited Bird and Sons located in Stark Industrial Park. Bird and Sons manufacture roofing and siding. Mr. Epting, plant engineer, showed us the outfall from their washing operations. He felt that the only thing that would be present in this water would be the soaps used for washing the siding and roofing along with fine grit and gravel. Mr. Epting informed us that the plant used several different chemicals, primarily dyes, for staining the gravels used in their roofing and siding. He offered to get us a list of these chemicals pending approval by the plant management. I agreed to return later in the week to get this list and also to get a sample from their washing operations. When I returned Mr. Epting gave me a sample of soap which is used almost continually and would show up in the wash water effluent (flow rate approximately 3,000 gallons per minute, 20 hours per day). The remainder of the chemicals are used in batch operations in vats with a volume of about 300 gallons. These vats may be emptied anywhere from one to four times per day depending on the plant's production schedules. This list is as follows: sodium silicate, aluminum fluoride, sodium fluosilicate, titanium dioxide, ammonium chloride, clay, chromium oxide, iron oxide, cobalt (oxide?) pigment, monastral blue pigment (water soluble), silicone, and boiler water treatment chemicals. The erratic schedule of the use of each of these chemicals would present a real sampling problem. Therefore, Mr. Epting volunteered to get samples from each of these operations if we supplied him with sampling containers. Mr. Epting will call Jim Finger at the Charleston Harbor Laboratory when he has accumulated all of the samples indicated and Mr. Finger will pick these up and see that they are sent to the Southeast Water Laboratory. The Bird and Sons Plant also has cooling water effluent which might contain some metals. This also will be sampled.

Water samples were also collected from the Ashley River from near Kopper's wood treating plant (CSC-11) and near an outfall far upstream (CSC-12) possibly emptying wastes from the military air base.

Other plants of the Ashley River complex, including Plant Hagood, an electric generating plant; the Southeastern Steel Company, and a couple of ready-mixed concrete companies, were felt by Mr. Beall not to present any problem and we did not visit these.

Later in the week I noticed another industry, Molony Fertilizer and Insecticide Company, which would not dump directly into the Ashley River but into one of the municipal sewers which empty into the river. Inquires about this industry indicate that they are a manufacturing and formulating industry, but due to the fact that pesticides were not thought to be the problem in the fish kills and also that Mr. Beall was no longer present, I did not try to enter this plant. Other industries noticed in the area which could be of possible

significance were the J. N. Moore Barrel Reclaiming Company and the Burruss Chemical Company. These were located in the vicinity of Bird and Sons. In addition to these industries, there are reported 11 municipal outfalls reported entering at scattered points along the Ashley River in the area where fish kills have been noticed.

Observations of Fish Kills

A scattering of dead fish were noticed on the evening of June 21 and an extensive kill occurred during the morning of June 22. Fish observed dying were primarily menhaden, a few small trout, and one mullet. The fish were behaving in the manner much as described by previous observers in that they were swimming slowly in circles, disorientated, and lying on their sides. Eighteen menhaden were obtained in a near dead condition and immediately frozen. These samples were returned to the Southeast Water Laboratory. All fish collected, with the exception of one, were clear and bright in color and did not have the characteristic red streak across the eye previously noted on the dead fish found in the Ashley River. Apparently this red streak develops right at or soon after death. A number of dark, reddish-colored menhaden, some with red streaks, were observed swimming near the surface of the water; but these were still too lively to catch. A majority of the dead fish observed did have the red streak. A sample of the water (CSC-10) was obtained in the vicinity where most of the fish kill appeared to be originating. A sample of mud was also collected in this area from a depth of 20 feet. Water samples were collected during the morning of June 24 between the hours of 9:30 and 10:30 A.M. from both the surface and deep water in order to determine the dissolved oxygen content, pH, and chlorinity. The range of dissolved oxygen in these samples was from 4.19 parts per million to 4.71 parts per million; the mean of three samples was 4.7 parts per million; the pH and chlorinity have not yet been determined. Six additional water samples were collected between the hours of 12 midnight and 1:30 A.M. to determine if there were diurnal differences, particularly in dissolved oxygen content. These six samples had an average concentration of 4.4 parts per million dissolved oxygen; the range was from 4.26 to 4.66 parts per million. These concentrations, while not normally considered low enough to be lethal to fish, nevertheless can be marginal for a particularly sensitive fish such as menhaden and fresh-water shad. High concentrations of free carbon dioxide in the water and/or presence of metals had been reported as seriously reducing fish population's ability to utilize dissolved oxygen even though it may be present in what are normally considered adequate amounts. The generally polluted nature of this stretch of the river makes this sort of inhibitation a distinct possibility.

Other Fish Collections

Arrangements were made with a Captain Shaffer, who operates two shrimp fishing vessels out of a port on Shems Creek in Mount Pleasant, South Carolina, to collect menhaden from off-shore, outside the influence of Charleston Harbor pollution. A chest containing dry ice was furnished to Captain Shaffer to be taken with him on the boat so that the fish could be placed immediately on

dry ice as soon as they were collected. Three boats were looking for menhaden, but they met with singularly poor success during the first two days. Seven fish were obtained, and these were brought back to the Southeast Water Laboratory for comparison to fish collected from the Ashley River near Charleston. The chest with dry ice was left with Captain Shaffer in the hopes that he would find more menhaden on his Saturday cruise. Mr. Jim Finger, of the Charleston Harbor Laboratory, is to pick these up and send them to the Southeast Water Laboratory if and when Captain Shaffer is successful in getting us more fish. In addition to these fish from uncontaminated waters, I have made arrangements to obtain actively swimming, apparently healthy fish from the Ashley River. The Bears Bluff Laboratory vessel is coming to the Ashley River during the week of June 28. Arrangements have been made to put a chest with dry ice aboard that vessel so that the crew can collect fish and turn them over to the Charleston Harbor Laboratory group to be sent on to the Southeast Water Laboratory. Dr. Lunz, Director of the Bears Bluff Laboratory, stopped by the Charleston Harbor barge one morning to see me and related that their trawler normally gets anywhere from ten to twenty times the amount of menhaden from the Ashley River compared to other rivers in the vicinity that are known to have about the same size menhaden populations. A trawler is not normally used to collect menhaden; the purse seine is. Most menhaden are successful in evading a trawl. Dr. Lunz feels that the reason for the high catch of menhaden by the trawl in the Ashley River may be due to the sluggishness of these fish resulting from the pollution in the area. It may be highly informative to get these fish in addition to those that were near dead, and those from the uncontaminated off-shore waters, for comparative purposes.

Gerald J. Lauer

Gerald J. Lauer

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GJLauer/es/7/13/65

CHARACTERIZATION OF INDUSTRIAL WASTE EFFLUENTS AND ASHLEY RIVER WATER

Sample	Date	Fe ppb	Zn ppb	Pb ppb	Cu ppb	Mn ppb	Cr ppb	Co ppb	Cd ppb	pH	VC-13 ppb	Merphos (Degradation Product) ppb	Phenols ppm
V-C Chemical Co.													
1	6/22/65	6,700	300	400	100	0	300	0	0	10.5	0.3	1.3	-
21	7/14/65	200	100	0	0	0	0	0	0	10.4	40	45	-
M-7	7/14/65	-	-	-	-	-	-	-	-	-	710,000	4,700,000	-
2	6/22/65	5,900	2,100	700	100	0	0	0	700	2.8	0	0	-
18	7/14/65	6,100	800	200	0	0	0	0	0	2.8	0.47	0	-
M-6	7/14/65	-	-	-	-	-	-	-	-	-	0	0	-
3	6/22/65	6,200	1,400	200	100	0	0	0	0	3.6	0	0	-
20	7/14/65	6,900	300	100	100	0	0	0	0	2.4	0.8	0	-
4	6/22/65	6,400	500	500	100	0	0	0	0	8.8	700	15,000	-
23	7/14/65	600	100	0	0	0	0	0	0	6.7	6500	0	-
24	7/14/65	700	100	100	0	0	0	0	0	7.2	5	500	-
M-8	7/14/65	-	-	-	-	-	-	-	-	-	300,000	5,000,000	-
M-9	7/14/65	-	-	-	-	-	-	-	-	-	330,000	240,000	-
5	6/22/65	3,400	700	300	200	0	0	0	0	8.7	400	0	-
22	7/14/65	700	100	0	0	0	0	0	0	6.3	7	0	-
6	6/22/65	400	200	200	0	0	0	0	0	5.7	0	0	-
19	7/14/65	100	300	100	0	0	0	0	0	6.6	0	110	-
7	6/22/65	300	100	0	0	0	0	0	0	5.7	0	0	-
27	7/14/65	300	100	0	0	0	0	0	0	0.5	0	0	-
M-11	7/14/65	-	-	-	-	-	-	-	-	-	0	0	-
8	6/22/65	0	0	0	0	0	0	0	0	4.8	0	0	-
25	7/14/65	100	100	0	0	0	0	0	0	6.7	0.1	1.7	-

(cont.)

CHARACTERIZATION OF INDUSTRIAL WASTE EFFLUENTS AND ASHLEY RIVER WATER

Sample	Date	Fe ppb	Zn ppb	Pb ppb	Cu ppb	Mn ppb	Cr ppb	Co ppb	Cd ppb	pH	VC-13 ppb	Merphos (Degradation Product) ppb	Phenols ppm
26	7/14/65	100	100	0	0	0	0	0	0	6.0	0	0	-
M-10	7/14/65	-	-	-	-	-	-	-	-	-	100	0	-
Planters Fertilizer Co.													
9	6/22/65	8,800	0	200	100	2,000	0	0	0	<0	0	0	-
14	7/14/65	1,500	0	100	50	500	0	0	0	1.7	0	0	-
M-2	7/14/65	-	-	-	-	-	-	-	-	-	0	0	-
15	7/14/65	100	1,400	100	6,500	2,300	0	200	0	4.5	0	0	-
M-3	7/14/65	-	-	-	-	-	-	-	-	-	0	0	-
Ashley R.													
10	6/23/65	600	100	0	0	0	0	0	0	6.9	0	0	-
29	7/15/65	Sample inadequate for metals analysis									0	0	0
11	6/26/65	800	100	0	0	0	0	0	0	6.9	0	0	-
12	6/26/65	600	100	0	0	0	0	0	0	7.1	0	0	-
28	7/15/65	Sample inadequate for metals analysis									0	0	0
32	7/12/65	200	300	0	0	0	0	0	0	6.3	1900	7300	-
M-12	7/15/65	-	-	-	-	-	-	-	-	-	0	210,000	-
M-13	7/15/65	-	-	-	-	-	-	-	-	-	0	3,800	-
M-14	7/15/65	-	-	-	-	-	-	-	-	-	500,000	1,600,000	-
M-15	7/15/65	-	-	-	-	-	-	-	-	-	0	0	-
M-16	7/15/65	-	-	-	-	-	-	-	-	-	0	0	-

(cont.)

CHARACTERIZATION OF INDUSTRIAL WASTE EFFLUENTS AND ASHLEY RIVER WATER

Sample	Date	Fe ppb	Zn ppb	Pb ppb	Cu ppb	Mn ppb	Cr ppb	Co ppb	Cd ppb	pH	VC-13 ppb	Merphos (Degradation Product) ppb	Phenols ppm
Hagood Plant													
13	6/25/65	100	300	0	0	0	0	0	0	6.9	0	0	-
33	7/15/65	100	300	0	0	0	0	0	0	6.2	0	0	-
Agrico Plant													
34	unknown	100	100	100	0	0	0	0	0	8.0	0	0	-
Koppers Co.													
16	7/14/65	11,700	1,100	200	200	1,000	0	0	0	4.6	-	-	450
M-4	7/14/65	-	-	-	-	-	-	-	-	-	-	-	20,000
17	7/14/65	5,700	600	200	100	1,000	0	0	0	2.0	-	-	0
M-5	7/14/65	-	-	-	-	-	-	-	-	-	-	-	-
Bird & Son Plant													
30	unknown	200	100	0	0	0	0	0	0	10.9	0	0	-
31	unknown	0	100	0	0	0	0	0	0	10.8	0	0	-

OPTIONAL FORM 10
MAY 1962 EDITION
GSA GEN. REG. NO. 27

UNITED STATES GOVERNMENT

Memorandum

TO : Files DATE: July 27, 1965

FROM : Dr. A. K. Williams, Scientist

SUBJECT: CHARLESTON HARBOR STUDIES: Acetylcholinesterase Inhibition

Introduction

Acetylcholinesterase (AChE) is an enzyme which catalyzes the hydrolysis of acetylcholine to choline and acetic acid. This enzyme, found primarily in nervous tissue such as the brain, is responsible for regulating the impulse-conducting ability of the nervous system.

The organophosphorus or "nerve-gas" insecticides owe their toxic properties to their ability to combine with AChE. This combination results in an enzyme which is no longer capable of carrying out its normal function.

With these facts established, it follows that exposure of animals to organophosphorus compounds should result in lower than normal levels of AChE activity. This has indeed been shown by several investigators to be the case.

In Vivo Studies

In this study, fish were taken from the Ashley River near Charleston, South Carolina, where extensive fish kills have occured over a period of several years. The level of AChE activity in the brain of these fish were compared with that of normal fish taken from waters off North Carolina; or, in the case of croakers, from the Ashapoo River, South Carolina.

Brain tissue from the fish was removed, prepared and assayed by the method of Weiss (1958). The results of these determinations are shown in Table 1. Menhaden, which were collected in near-dead condition, were found to be inhibited by 49.3% of normal when compared to menhaden taken from non-polluted waters off North Carolina. Menhaden taken from the Ashley river, but which were not in great distress, were found to be inhibited by only 26.3%.

Weiss has reported that a number of fish tested began to show some evidence of poisoning by organophosphorus compounds when their brain AChE level showed about 15% inhibition and that death began to occur at approximately 40% inhibition. These findings agree with the data presented in this report.

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In addition to the menhaden mentioned above, croakers taken from the Ashley river showed a 35.5% inhibition when compared with the same species taken from the non-polluted Ashapoo river.

In Vitro Studies

Water samples taken in the vicinity of the Ashley river were extracted with chloroform and the chloroform fractions assayed for the presence of materials capable of inhibiting AChE in Vitro.

These determinations were made by placing a measured amount of the chloroform extract into test tubes and evaporating the solvent in an air stream. Purified AChE was then placed in the tubes and allowed to react with the inhibitor (if present) for 30 minutes. The tubes were then assayed for AChE activity as before. Control reactions using pure chloroform were used to determine the 100% activity level.

Water samples numbers 4, 5, and 9 showed significant inhibition of AChE in Vitro.

Table 2 shows the relative inhibition of AChE exhibited by these extracts when compared to the control (uninhibited) reaction. In the case of the #4 sample, the equivalent of 0.04 ml of water gave an inhibition of 37%.

Conclusions

Menhaden and croakers taken from the Ashley river, South Carolina, were found to have abnormally low acetylcholinesterase levels in brain tissue. Dying fish had the lowest levels of AChE (49.3% inhibition) while menhaden taken from the same area, but not actively dying, were only 26.3% inhibition.

Croakers taken from the Ashley river showed a 35.8% inhibition.

In Vitro inhibition of AChE was observed in three of twelve water samples taken from the vicinity of the Ashley river. All samples having inhibitory properties were taken from effluents of the Virginia-Carolina Chemical Company.

AKWilliams/kt/7/28/65

TABLE 1

In Vivo AChE Activity

Sample	Number Assayed	Average Specific Activity	Average Percent Inhibition
Control, menhaden from North Carolina	18	1.14	0
10a-g menhaden, Ashley River, near dead	8	0.58	49.3
9a-h menhaden, alive from Ashley river	8	0.82	26.3
Control, croakers Ashapoo river	8	1.48	0
8a-h croakers from Ashley river	8	0.95	35.8

TABLE 2

In Vitro Inhibition of AChE by Water Samples

Sample	Percent Inhibition (0.5 ml. water)
Control	---
#4	95
#5	42
#9	29

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UNITED STATES GOVERNMENT

Memorandum

TO : J. R. Thoman
Director, Southeast Water Laboratory

DATE: July 16, 1965

FROM : G. J. Lauer and Q. J. Stober

SUBJECT: Field Trip Report. Charleston, S. C.-Ashley River Fish Kills Investigation

Liquid samples (designated CSC-#) and sediment samples (designated CSC-M-#) were collected from the following industrial waste outfalls and Ashley River locations on the dates July 14 and 15, 1965:

14 July 1965

A. Planters Fertilizer Company
CSC-14 Process drainage ditch
CSC-M-2 Process drainage ditch

CSC-15 Roof drain ditch
CSC-M-3 Roof drain ditch

B. Koppers Wood Preservative Plant
CSC-16 Central ditch from most of wood treating operations.
CSC-M-4 Central ditch from most of wood treating operations.

CSC-17 Common ditch between Planters Fertilizer Co. plant and Koppers. Liquid sample mostly from small ditch of Koppers
CSC-M-5 Companion to CSC-17. Most of sediment from Planters Fertilizer Co. effluents. This granular, white sediment 6 inches deep at sides of ditch, 2 feet deep at center. Ditch was about 5 feet wide and 300 yards long to Ashley River.

C. V. C. Chemical Division Chemical Plants
CSC-18 Phosphorus furnace and cooling water effluent
CSC-M-6 Phosphorus furnace and cooling water effluent

CSC-19 Phosphoric acid plant cooling water (river water source).
CSC-20 Phosphoric acid plant process water (well water source).

CSC-21 Merphos Plant effluent
CSC-M-7 Merphos Plant effluent ditch
CSC-22 Organic phosphite and phosphate plants effluent
CSC-23 Upstream of newly installed dike for skimming floating film on ditch accepting both Merphos Plant and organic phosphite-phosphate plants.

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CSC-M-8 Sediment sample at site of CSC-23 liquid sample
CSC-24 Downstream of dike and road bed on ditch accepting both Merphos Plant and organic phosphite-phosphate plants

D. V. C. Agricultural Products Division Chicora (H_2SO_4) Plant east of V. C. Chemical
CSC-25 Cooling water effluent

CSC-26 Ditch from (?) between V. C. H_2SO_4 (Chicora) Plant and V. C. Chemical plants.
CSC-M-10 " " " " " " " " "

E. V. C. Agricultural Products Division Standard Plant (west of V. C. Chemical plants).
CSC-27 Ditch accepting both cooling water from H_2SO_4 plant and process water from fertilizer plant.

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F. Ashley River
CSC-M-12 Immediately above U. S. Highway 17 Ashley River Bridge. Depth 30 ft.
CSC-M-13 One-fourth mile downstream of Agrico Fertilizer Plant. Depth 21 feet. Two hauls of Ekman dredge.
CSC-M-14 Approximately 40 feet offshore of V. C. Chemical's Merphos outfall. Depth 4 to 10 feet. Three hauls of Ekman dredge.
CSC-28 Water from ditch to outfall located far upstream on Ashley - possibly from Airbase.
CSC-29 Water from site where fish were observed dying...offshore from V. C. Chemical plants.
CSC-M-15 Far upstream, approximately 2 miles upstream of ACL Railroad Bridge (sand bottom-"clean" odor), depth 10 feet.
CSC-M-16 Far upstream, just downstream of ACL Railroad Bridge, sand...lemon odor, depth 34 feet.

G. Plant Hagood
CSC-30 Cooling water effluent - Samples picked up by PHS Charleston personnel.

CSC-30 Bird and Son
CSC-31 Bird and Son
CSC-32 Ashley River below Koppers, lemon odor film widespread on surface.
CSC-34 Agrico H_2SO_4 Plant cooling water effluent.

NOTE: Some industrial outfalls had no sediment to be sampled.

Observations and comments:

A Mr. Shulte, Assistant Plant Manager, accompanied us during collection of

effluents from V. C. Chemical Plants in place of Mr. Enos. With use of a copy of "Location of Outfalls into the Ashley River from South Battery up to Henley Park" (provided by the South Carolina Water Pollution Control Authority) which includes rough sketches of the industry's plant layout, and benefit of Mr. Shulte's elaboration, a more accurate description of certain V. C. Chemical's outfalls were obtained as follows:

1. Outfall previously described as effluent from phosphoric acid plant is outfall from organic phosphite and phosphate plants. Previous description of sample CSC-5 should be changed accordingly. This clears up mystery as to why CSC-5 produced inhibition of Cholinesterase activity.

2. Outfall previously described as well water source cooling water from phosphoric acid plant is process water from phosphoric acid plant. Description of sample CSC-3 is amended accordingly.

V. C. Chemical has installed a dike with a sub-surface discharge intake on the common ditch accepting effluent from the Merphos and organic phosphate-organic phosphite plants for collection of floating wastes. This has been done since the 6-22-65 sampling trip. The skimmed off wastes are "removed and burned."

A black hose of about 3-inch diameter was observed partially submerged in the bottom of the above described ditch. The metal unions were new-bright. The hose was disjointed at a spot near the bank slope of the Ashley River. The section of hose lying on the bank, when connected, would be long enough to reach the water of the Ashley River. When asked the purpose of this hose, Mr. Shulte replied, "It is used to carry wastes from one of our processes." Asked what process, he evaded the question. Asked if there was some particular reason for this special provision being made, Mr. Shulte replied, "A little bit of a reason." No discharge was coming from the hose at this time but Mr. Shulte indicated that it has been used. When asked about the use of the lemon-odored masking substance almost covering the surface of the ditch on the 6-22-65 sampling trip, reported to cover the surface of the Ashley for several miles on 7-12-65, but not much in evidence except for the odor on 7-15-65, Mr. Shulte replied, "We've had such clean operations that we haven't used such things for years.

Sick and freshly killed fish were observed in the Ashley River on the morning of 15 July 1965. An estimated several hundred dead menhaden, six crabs, and a half dozen sick menhaden were concentrated in a very restricted area (about 50 yards wide and 500 yards long) along the shore from the Hagood Plant upstream past the V. C. Chemical Plants. The tide was high and just beginning to ebb. The area from which dying fish were collected on 22 June 1965, while more widespread, also centered on this industrialized portion of the Ashley. There is little doubt that the ultimate cause(s) of these two kills emanated from this industrial complex.

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The Molony Insecticide and Fertilizer Company, located on King Street in the vicinity of V. C. Chemical Company, formulates and mixes a wide variety of insecticide dusts and liquids, but have no liquid waste disposal other than toilets going to septic tanks.

Gerald J. Lauer, Jr.

GJLauer/es/7/16/65